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The agreement of the comet spectrum with the strong bands and lines in the carbon and cyanogen spectra is perfect, within the limits of error, except that the wave-lengths for the comet are systematically less by one or two tenth-metres than KAYSER and RUNGE'S results. At first I was inclined to attribute the discordance to the large flexure of the spectroscope when the great telescope is in nearly a horizontal position. But the same discordance exists also in the visual observations, which are not affected by flexure. An explanation may possibly be found in the fact that in the various spectra we have to deal with unsymmetrical bands, to some extent, rather than with lines.

The photographs of KAYSER and RUNGE do not include the carbon line at 4675; but it has been observed by HASSELBERG and by WATTS; and the photographs of the spectra of Bunsen flames and of cyanogen flames made by H. W. VOGEL show the five lines in the blue band and the unresolved part of the band exactly as observed by me in the comet spectrum. KAYSER and RUNGE'S work does not cover the region 4366–4234; but VOGEL'S photographs of the cyanogen spectrum contains lines which probably are identical with the comet lines at 4366 and 4313, and possibly with a few others.

All the observations were made with a dense 60° prism.

The 36-inch telescope presents several positive disadvantages for comet spectrum work, of which I may mention two.

The ratio of focal length to aperture, 19:1, is much larger than exists in small telescopes, and hence the latter would form much brighter images on the slit-plate than the former.

The guiding in photographic work with the long telescope is difficult with low and rapidly moving objects.

COMPARISON OF THE NEW STAR SPECTRUM WITH THE SPECTRA OF FIVE WELL-KNOWN NEBULÆ.

By W. W. CAMPBELL.

The earliest observations of the August, 1892, spectrum of *Nova Aurigæ* convinced me that it was nebular. There was not the slightest resemblance to any other known type. The continuous spectrum was extremely faint, as in the case of the planetary nebulæ; the spectrum consisted almost wholly of isolated bright lines; the three brightest lines had the relative positions and intensities of the three characteristic nebular lines; and a hasty examination of four well-known nebulæ resulted at once in finding eight other nebular lines which corresponded to eight of the prominent lines in the new star. Without tabulating the results of the comparison with nebular spectra, I stated, in September and October, that "The spectrum is that of a planetary nebula, * * * Nearly all these lines have been found either in the planetary nebula Σ 6 or in the *Orion Nebula*; the lines in *Nova's* spectrum, however, being displaced four or five tenth-metres towards the violet."

A question having been raised by Dr. and Mrs. HUGGINS, and by Professor VOGEL*, as to whether the spectrum is really nebular or not, I made a few more visual and long-exposure photographic observations of nebular spectra. Without any difficulty I found five additional nebular lines, which also exist in the new star. The wave-lengths of all the bright lines thus far observed by me in five nebulæ and in the new star are herewith tabulated:

Orion Nebula.	G. C. 4390. Σ 6.	N. G. C. 7027.	G. C. 4964.	G. C. 4373.	*Nova Aurigæ.*
D_3	5876	D_3	....	....	....
....	....	5751	....	....	5750
....	....	5412	....	....	....
....	....	5313	532	....	....
5007	5007	5007	5007	5007	5002
4959	4959	4959	4959	4959	4954
4862	4862	4862	4862	4862	4857
....	4743	4743	4744	....	....
4713	4714	4716	4714	....	471
....	4687	4688	4686	....	4681
4661	4663	....	4663	....	....
....	4637	4631	4640	....	4630
....	4610	....	....	....	460
....	4595	....	....	....	....
....	4574	....	....	....	....
....	....	....	....	....	451

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* Professor VOGEL inclines to the view that the bright lines are chromospheric.

Orion Nebula.	G. C. 4390. Σ 6.	N. G. C. 7027.	G. C. 4964.	G. C. 4373.	*Nova Aurigæ.*
4473	4473	....	4472	4472	4466
4390	4390	....	....	....	438
4363	4364	4363	4364	4363	4358
4341	4341	4341	4341	4341	4336
427	....	....	....	....	426
424	....	....	....	....	423
4102	4102	4102	4102	4102	4098
4067	....	....	4067	4067	....
4026	4026	...	4026	4026	....
3969	3969	....	3969	3969	396
3889	....	....	....	3888	...
3868	3868	....	3868	3867	....
3836	....	....	....	....	....

I have omitted from my original list of *Nova* lines those at [5570] and 5268, for the reason that they were too faint to permit an accurate determination of their wave-lengths. I have not searched for lines in the nebulæ at those places, since the new star lines are not well enough fixed to make a successful search of any value, but Professor VOGEL has observed faint lines in some of the nebulæ at 5540 and 5270, which could easily be identical with the two *Nova* lines observed by me.

I am not certain that any of the nebulæ contain a line near wave-length 451; but all the other *Nova* lines can be said to be matched perfectly in one or more of them, allowing for the fact that the *Nova* lines were shifted (in August and September, 1892) about five tenth-metres towards the violet. The *Nova* spectrum differs no more from the nebular spectra than the nebular spectra differ from each other; and as it resembles the nebular type perfectly, and bears no resemblance to any other known type, there can be no reason for changing my statement made last year that "the spectrum is that of a planetary nebula."

Dr. and Mrs. HUGGINS began to observe the new star spectrum in February, 1893. Their observations* were confined entirely to the three principal lines in the spectrum, and indeed almost wholly to the brightest one of the three. They write that as soon as they directed the spectroscope to the star (February 1, 1893) they saw at once, even with one prism, that the two principal bright bands which had been described as the "nebular lines" were in strong contrast with those, not single lines, but broad bright spaces, diffused at the ends and irregularly bright, which they suspected to be groups of bright lines.

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* Described in a paper recently read before the Royal Society of London.

These characteristics of the lines agree perfectly with those described by me one year ago, in my first article on the *Nova*, except that in addition I observed several changes in the appearance of the brightest line. At that time I wrote: "* * * The difficulties in the way of deciding the question arise not from the faintness of the lines, but from their great breadth. They are more diffuse than those of any of the planetary nebulæ which I have observed. With the grating the line λ 5002 is at least eight tenth-metres broad, with diffuse edges, and a brighter central region about four tenth-metres broad. On August 30 the line was suspected to be double, and the grating measures of that night refer to a point midway between the two condensations. On September 7 the measures refer to a point of maximum brightness slightly less refrangible than the centre of the line." (See *Astronomy and Astro-Physics*, October, 1892, p. 718.)

Further, I have *always* described the lines as abnormally broad, and have observed that the appearance of the brightest line *changes*. On August 23, 1892, I measured the positions of two apparent maxima at wave-lengths 5005.9 and 5000.3. In September, October and November,* 1892, the maximum intensity was at the centre of the band. In February and April, 1893, the band was broader and nearly of uniform intensity throughout. At no time has there been any excuse for making an error of one tenth-metre in measuring the wave-length of the centre of the band.

As a result of further observations Dr. and Mrs. HUGGINS conclude that the bands at λ 501 and λ 496 consist of lines more or less bright upon a feebly luminous background, with possibly some absorption lines. Their work in the rest of the spectrum was confined to satisfying themselves, "by a direct comparison, that the line about F was really the hydrogen line in that region."

They wish to speak at present with great reserve concerning the character of the spectrum, since the observations are incomplete; but they "do not regard the circumstance that the two groups of lines above described fall near the positions of the two nebular lines as sufficient to show any connection between the present physical state of the *Nova* and that of a nebula of a class which gives these lines."

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* See *Astronomy and Astro-Physics*, February, 1893, p. 149

I can readily assent to that conclusion.

But in interpreting the spectrum of *Nova* we must not limit ourselves to our knowledge of those two bands or groups of lines. The rest of the spectrum must also be considered. Now, Dr. and Mrs. HUGGINS, and several other observers, have found that the intensities and relative positions of the three most prominent lines or bands in this spectrum agree *perfectly*, within the limits of error, with those of the three most prominent nebular lines*. I have observed nineteen lines in the *Nova*, eighteen of which may be said to correspond perfectly to lines in the nebulæ. Herr VON GOTHARD has observed seven lines, six of which he believed to exist in the spectra of several nebulæ. Four of these six coincide with four lines in my list, and the other two are in the ultra-violet, quite beyond the limits of my photographs of the *Nova* spectrum. Now, if only the brightest two of the twenty-one known lines were broad bands or groups of lines, and the other nineteen were narrow and well-defined, a question might possibly be raised as to the origin of the two groups. But such is not the case.

The "line about F" is seen with the large telescope to be a band, apparently identical in form with those at the positions of the two chief nebular lines; and likewise, with certainty, those at 463 and 436. Whether the fifteen fainter lines and the one at λ 575 are also very broad, it is impossible now to say; but in all probability they are. If any *one* of these bands consists of a group of lines, it is very probable that they *all* do; and it would not, then, be a question of identifying each line in each group with some chemical element, but of observing *the arrangement of the lines in the groups*, in the hope of solving the problem of whether the *Nova* is *one* nebula, or a system of *several* nebulæ.

The lines in the February, 1892, spectrum occupied in general the positions of the solar chromosphere lines: those lines were broad, and many of them were multiple; but those facts did not prevent us from arguing that the spectrum was chromospheric.

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* My recent observations of these three bands in *Nova* give for their wave-lengths, 5006.0, 4958.3, 4860.2. These wave-lengths have increased or decreased simultaneously since August, 1892, and the intervals between them are the same as in the case of the well-known nebulæ.

The lines in the present spectrum do not occupy the positions of the prominent lines in the February, 1892, spectrum, nor the positions of lines in the solar chromosphere, nor the positions of the lines in any of the bright line stars; *they do occupy the positions of the lines in the nebulæ;* the spectrum resembles nebular spectra as closely as well-known nebular spectra resemble each other: therefore the spectrum is nebular, and the fact that the lines have remained broad, or may have remained multiple, does not militate against the theory.

MT. HAMILTON, August 11, 1893.

SOLAR ECLIPSE, OCTOBER 9, 1893.

TIMES OF BEGINNING, ENDING, POSITION-ANGLES, ETC., FOR THE FOLLOWING PLACES IN THE STATE OF WASHINGTON.

	SEATTLE. Lat. 47° 35′ Long. $8^h\ 9^m\ 20^s$		CHEHALIS. Lat. 46° 40′ Long. $8^h\ 11^m\ 52^s$		SPOKANE. Lat. 47° 40′ Long. $7^h\ 49^m\ 40^s$	
	BEGINS. A. M.	ENDS. P. M	BEGINS. A. M.	ENDS. P. M.	BEGINS. A. M.	ENDS. P. M.
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.
Pacific Standard	10 27 20	12 31 9	10 24 23	12 32 52	10 41 13	12 32 9
Local	10 18 00	12 21 49	10 12 31	12 21 00	10 51 33	12 42 29
Duration .. .	$2^h\ 3^m\ 49^s$		$2^h\ 8^m\ 29^s$		$1^h\ 50^m\ 56^s$	
Moon's Hourly Motion in Relative Orbit...	1298.9″		1289.5″		1296.3″	
Magnitude ...	.29		.31		.22	
Position Angle.	S. of W. 3° 34′ 57″	E. of S. 4° 5′ 23″	S. of W. 1° 54′ 20″	E. of S. 5° 30′ 16″	S. of W. 10° 21′ 18″	W. of S. 0° 48′ 22″

The position angle has been located with reference to the nearest point of the quadrant on the Sun's disc, and not from the north towards the east, as is usual.

As this eclipse is annular, it is of some interest to know how much the shadow lacks of reaching the earth. I have made a computation, and have reached the following results: